Claims

[c1] 1. A fuel injection system comprising a nozzle (2) with an inlet and a needle (15); a resilient means (14) biasing the needle (15) to close the nozzle (2); a control piston (16) forming a control chamber (17) and abutting the needle (15) such that a higher pressure in the control chamber (17) tends to urge the control piston (16) onto the needle (15) to close the nozzle (2); a cam-driven plunger (5) forming a plunger chamber (7), said plunger chamber connected to the inlet of the nozzle (2); a common rail (11) for fuel; a feed line (13); an electrically operated valve (9) being able to isolate said plunger chamber (7) from the common rail (11) and connect the plunger chamber (7) to the feed line (13) while in a third position, isolate the plunger chamber (7) from both the feed line (13) and the common rail (11) while in a second position, and isolate the plunger chamber (7) from the feed line (13) and connect the plunger chamber (7) to the common rail (11) while in a first position; a means (12) for pressurizing a feed line (13) with a relatively low fuel feed pressure; and a fuel tank (20), said fuel injection system characterized in that said control chamber (17) is connected to the common rail (11).

[c2] 2. The fuel injection system as recited in claim 1, wherein a non-return valve (10) is installed between said feed line (13) and the plunger chamber (7), with the inlet of said non-return valve connected to the feed line (13).

[c3] 3. The fuel injection system as recited in claim 1, further comprising an electrically operated nozzle control valve (NCV) (3), said NCV being able to isolate said control chamber (17) from said feed line (13) and open hydraulic communication between the control chamber (17) and said common rail (11) while in a first position and being able to isolate the control chamber (17) from the common rail (11) and hydraulically connect the control chamber (17) to the feed line (13) while in a second position.

[c4] 4. A fuel injection system comprising a nozzle (2) with an inlet and a needle (15); a resilient means (14) biasing the needle (15) to close the nozzle (2); a control piston (16) forming a control chamber (17) and abutting the needle (15) such that an [sic] higher pressure in the control chamber (17) tends to urge the control piston (16) onto the needle (15) to close the nozzle (2); a cam-driven plunger (5) forming a plunger chamber (7), said plunger chamber connected to the inlet of the nozzle (2); a common rail (11) for fuel; a feed line (13); an electri-

cally operated valve (9) being able to isolate said plunger chamber (7) from the common rail (11) and connect the plunger chamber (7) to the feed line (13) while in a third position, isolate the plunger chamber (7) from both the feed line (13) and the common rail (11) while in a second position, and isolate the plunger chamber (7) from the feed line (13) and connect the plunger chamber (7) to the common rail (11) while in a first position; an electrically operated nozzle control valve (NCV) (3), said NCV being able to isolate said control chamber (17) from said feed line (13) and open hydraulic communication between the control chamber (17) and said plunger chamber (7) while in a first position and being able to isolate the control chamber (17) from the plunger chamber (7) and hydraulically connect the control chamber (17) to the feed line (13) while in a second position; a means (12) for pressurizing a feed line (13) with a relatively low fuel feed pressure; and a fuel tank (20).

[c5] 5. The fuel injection system as recited in claim 4, wherein a non-return valve (10) is installed between said feed line (13) and the plunger chamber (7), with the inlet of said non-return valve connected to the feed line (13).

[c6] 6. A fuel injection system for an internal combustion engine comprising a nozzle (2) with an inlet; a cam-driven plunger (5) forming a plunger chamber (7), said plunger

chamber connected to the inlet of the nozzle; a common rail (11) for fuel; a feed line (13); an electrically operated valve (9) being able to isolate said plunger chamber (7) from the common rail (11) and connect the plunger chamber (7) to the feed line (13) while in a third position, isolate the plunger chamber (7) from both the feed line (13) and the common rail (11) while in a second position, and isolate the plunger chamber (7) from the feed line (13) and connect the plunger chamber (7) to the common rail (11) while in a first position; an electrically actuated nozzle control valve (23) for opening and closing of the nozzle (2); a means (12) for pressurizing a feed line (13) with a relatively low fuel feed pressure; and a fuel tank (20).

[c7] 7. The fuel injection system as recited in claim 6, wherein a non-return valve (10) is installed between the feed line (13) and the plunger chamber (7), with the inlet of said non-return valve being connected to the feed line (13).

[c8] 8. A fuel injection system for an internal combustion engine comprising a nozzle (2) with an inlet; a cam-driven plunger (5) forming a plunger chamber (7), said plunger chamber connected to the inlet of the nozzle; a common rail (11) for fuel; an electrically operated valve (9) installed between the plunger chamber (7) and the com-

mon rail (11), said valve (9) being able to open or close hydraulic communication between the plunger chamber and the common rail upon receiving an electrical control command; an electrically actuated nozzle control valve (23) for opening and closing of the nozzle (2); a means (12) for pressurizing a feed line (13) with a relatively low fuel feed pressure; a fuel tank (20); a non-return valve (10), characterized in that the inlet of said non-return valve is connected to the feed line (13) and the outlet of the non-return valve is connected to the plunger chamber (7).

[c9] 9. A fuel injection system comprising a nozzle (2) with an inlet and a needle (15); a resilient means (14) biasing the needle (15) to close the nozzle (2); a control piston (16) forming a control chamber (17) and abutting the needle (15) such that an [sic] higher pressure in the control chamber (17) tends to urge the control piston (16) onto the needle (15) to close the nozzle (2); a cam-driven plunger (5) forming a plunger chamber (7), said plunger chamber connected to the inlet of the nozzle (2); a common rail (11) for fuel; an electrically operated valve (9) installed between the plunger chamber (7) and the common rail (11), said valve (9) being able to open or close hydraulic communication between the plunger chamber (7) and the common rail (11) upon receiving an

electrical control command; a means (12) for pressurizing a feed line (13) with a relatively low fuel feed pressure; a fuel tank (20); a non-return valve (10), wherein the inlet of said non-return valve is connected to said feed line (13) and the outlet of the non-return valve is connected to the plunger chamber (7); said fuel injection system characterized in that said control chamber (17) is connected to the common rail (11).

[c10] 10. The fuel injection system as recited in claim 9, further comprising an electrically operated nozzle control valve (NCV) (3), said NCV being able to isolate said control chamber (17) from said feed line (13) and open hydraulic communication between the control chamber (17) and said common rail (11) while in a first position and being able to isolate the control chamber (17) from the common rail (11) and hydraulically connect the control chamber (17) to the feed line (13) while in a second position.

[c11] 11. The fuel injection system as recited in claim 10, wherein said NCV isolates said control chamber (17) from said feed line (13) and opens hydraulic communication between the control chamber (17) and said plunger chamber (7) while in a first position and isolates the control chamber (17) from the plunger chamber (7) and hydraulically connects the control chamber (17) to

the feed line (13) while in a second position.

[c12] 12. The fuel injection system as recited in claim 1, wherein said control chamber (17) is provided with an input throttle (18) and an outlet port (19), further wherein said input throttle (18) is connected to said common rail (11) and the only function of said NCV (3) is to open or close hydraulic communication between said outlet port (19) and said feed line (13), said fuel injection system characterized in that the effective flow areas of said input throttle (18), outlet port (19) and the NCV (3) and the force of said resilient means (14) are chosen such that an opening of the NCV can cause said needle (15) to open said nozzle (2) when the pressure at the inlet of the nozzle is sufficiently high.

[c13] 13. The fuel injection system as recited in claim 4, wherein said control chamber (17) is provided with an input throttle (18) and an outlet port (19), further wherein said input throttle (18) is connected to said plunger chamber (7) and the only function of said NCV (3) is to open or close hydraulic communication between said outlet port (19) and said feed line (13), said fuel injection system characterized in that the effective flow areas of said input throttle (18), outlet port (19) and the NCV (3) and the force of said resilient means (14) are chosen such that an opening of the NCV can cause said

needle (15) to open said nozzle (2) when the pressure at the inlet of the nozzle is sufficiently high.

[c14] 14. The fuel injection system as recited in claim 12, wherein said outlet port (19) and the control piston (16) are designed such that the control piston (16) is able to restrict the flow area of the outlet port (19) at a position corresponding to an open nozzle (2), thereby limiting the leakage of pressurized fuel through the input throttle (18), output port (19) and open NCV (3) to the feed line (13).

[c15] 15. The fuel injection system as recited in claim 1, wherein a sensor (22) is provided to supply information about the pressure of the fuel in the common rail to an engine management system (21).